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ABSTRACT

Guthrie, Bennett, and Weber (1990) have proposed a transformational model of procedural document processing. They suggest that successful completion of written instruction occurs when sources of information are combined with certain cognitive processes. Optimal combinations of information and cognition include the following: using the exposition to help form the conceptual model of the task; using the written steps to help encode the procedures (identify and execute the steps); and using the graphic representation of the outcome to foster self-testing. To recognize or select well-constructed procedural documents, text and graphics must be examined carefully. Accommodating the tendency of the reader to like and use pictures is an important part of creating well-constructed documents to enhance reader performance. Adding text is necessary for optimal performance. Effective written instructions do the following: (1) represent the procedure in a list of separate executable actions, often in a hierarchical format; (2) present relationships between actions and progress on the procedure; (3) provide access to information about the outcome; (4) give action information first in the sentences; and (5) give organization information before step information. Tools to help the reader encode the procedure include listing, formulas and guidelines, and procedural schema. Test features to improve reader performance include increased amounts of self-testing and self-correcting. (Appendixes include 59 references and 2 descriptions of procedural tasks.) (YLB)

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Improving Written Instructions for Procedural Tasks

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IMPROVING WRITTEN INSTRUCTIONS FOR PROCEDURAL TASKS

Introduction

People spend an average of nearly 2 hours a day engaged in reading job-related procedural documents in order to perform a task (Diehl & Mikulecky, 1980; Sticht, 1975). These documents contain "most of the difficult language that a reader encounters in daily life" (Simon & Hayes ,1976, p. 270). Analysis of data from the National Assessment of Educational Progress (NAEP) survey of young adult literacy revealed that, on the job,workers spent more time daily in reading manuals and guides, or "reading-to-do," than in reading general information or other reading materials (Guthrie, Schafer, & Hutchinson, 1989). Some researchers (Diehl & Mikulecky, 1980; Sticht et al., 1977) report that over half of reading tasks on the job are reading-to-do, encompassing an understanding of technical language, diagrams, and illustrations (Chang, 1983; Cranney, Rowley, & Stonehocker, 1984). However, only one fifth of young adults sampled in recent NAEP surveys demonstrated the advanced reading skills necessary for understanding complex texts of the sort that might be found in a technical working environment (Applebee, Langer, & Mullis, 1987).

Why do people have difficulty reading-to-do? Some claim that "many readers have never received any direct instruction in how to read instructions" (Henk & Helfeldt, 1987, p. 602). In a study by Hayes and Henk (1986), none of approximately 100 high school readers remembered receiving any formal training in following written instructions. Students also may not have sufficient exposure to procedural documents to become adept at using them, with or without direct instruction. A recent sample of 17-year-olds in the 1986 NAEP survey reported reading procedural materials (books on how to do, make, or repair something) approximately 1.1 times per week (Guthrie, Schafer, & Wang, 1990). These findings may help explain why good and average readers follow instructions well only about 85% of the time, while poor readers are lucky to succeed 50% of the time (Fox & Siedow, 1980).

It appears, then, that while reading-to-do tasks abound in the workplace, in general, students are not well prepared to perform such tasks. Unfortunately, little is known about the cognitive processes that underpin the comprehension of procedural documents, although the cognition underlying reading comprehension has been a major research focus for many researchers, agencies, and institutions. This research focus, however, was on the

processes that students employed when they read narrative and/or expository texts (see Kintsch, 1985; Mandler & Johnson, 1977; Meyer, 1980; Trabasso, Secco, & van den Broek, 1984, for models of reading processes based on these genre). Formulating and testing models of procedural text/document processing have apparently not attracted much research attention.

Only a very few researchers have attempted to study procedural document processing (Diehl, Mills, Birkmire, & Mou, 1989; Mark & Bracewell, 1989). Results of both of these studies indicate less than satisfactory transfer of what we know about narrative text to procedural text. To address these problems, Guthrie, Bennett, and Weber (1990) have proposed a model of procedural text comprehension very different from the models examined by Diehl et al. and by Mark and Bracewell.

A Transformational Model of Procedural Document Processing. Guthrie and his colleagues suggest that successful completion of written instructions occurs when sources of information are combined with certain cognitive processes. These cognitive processes are believed to be different from the cognitive processes required by non-procedural documents (see also Diehl & Mikulecky, 1980). The sources of information in written instructions for procedural tasks and the cognitive processes believed to be necessary are summarized here.

Sources of Information:

1. Exposition of the outcome (an overview of the process in prose, or a statement of purpose, containing information about the nature of the outcome),

2. Procedural steps (a list of separate, executable, required actions),

3. Representation of the outcome (a description of the anticipated outcome whether in the form of pictures/illustrations, or text), and

4. The workspace (which includes partially assembled equipment or half-drawn figures).

Cognitive processes:

1. Forming a conceptual model (creating a mental idea of how to do the task that can help the reader use the written materials),

2. Encoding procedures (identifying separate steps and entering them into memory),

3. Self-testing (asking oneself "Do I understand what I've read and have I done it correctly?"), and

4. Self-correcting (repairing mistakes identified by self-testing).

Guthrie et al. (1990) suggest that optimal combinations of information and cognition include (a) using the exposition to help form the conceptual model of the task; (b) using the written steps to help encode the procedures (identify and execute the steps); and (c) using the graphic representation of the outcome (pictures or drawings) to foster self-testing. They do not suggest an optimal combination that might foster self-correction activities because of a lack of research into this type of cognitive activity .

The testing of the Guthrie et al model is limited (see Burnham, 1991; Burnham & Anderson, 1991), but even preliminary results indicate that written instructions can be improved by following the hypotheses in the model. These results and their implications are discussed below.

Recognizing and Selecting Well-Constructed Procedural Documents

Two important points should be made prior to discussing what has been learned about written instructions for procedural tasks. First, recognizing and/or selecting well constructed procedural documents requires some distance on the part of the reader from both the subject of the instructions and her/his pre-reading ability to do the task. The document must be examined from the viewpoint of a novice. This is not an easy task for the creator of written instructions. Second, "procedural text" is a misnomer, as the accomplishment of the majority of procedural tasks involves the use of objects (assembly tasks, map reading, recipes, blueprint reading, sewing projects, computer instruction, etc.).

Therefore, when recognizing or selecting well-constructed procedural documents graphics as well as text must be examined carefully.

Graphics. Line drawings seem to promote understanding of the spatial content (location, orientation, or composition of an object) of instructional materials more than shaded drawings or photographs (Dwyer 1971, 1972; Readence & Moore, 1981) although the use of color may reverse this effect by heightening student interest and motivation (Dwyer, 1972). Readers may prefer to use the pictures or photographs which appear in written instructions for procedural tasks (LeFevre and Dixon,1986) because they remember them better than the text (Haber, 1970; Nickerson, 1965; Shepard, 1967; Standing, Conezio, & Haber, 1970), because they enhance finding information in memory (Seymour, 1974), or because they are versatile, capable of conveying the several types of spatial information mentioned above (Bieger & Glock, 1984, 1986; Schorr and Glock, 1983; Stone, 1977a, 1977b).

High school students who were required to read the text of written instructions aloud frequently read hurriedly, as if the text were an intrusion and the important information was in the drawings. A few subjects used the pictures almost exclusively, and in the process made great improvement on task accomplishment (see Burnham,1991). The author's experience in sewing labs supports the suggested tendency of students to avoid reading text and to try to use drawings exclusively.

Examples of texts used to test Guthrie et al's (1990) model appear in Appendix A. Both Text A and Text B have inadequate graphics. Text A has photographs, which reproduced poorly, even in the original, and Text B has line drawings. In none of the illustrations is the underside of the fabric shown and little perspective is provided to help the reader calculate hand positions relative to button and fabric. A third text created to test the Guthrie (1990) model appears in Appendix B. When this text was used task accomplishment was significantly improved over that accomplished when using both Text A and Text B (see Burnham, 1991). Part of the improvement in task performance likely came from the presence of over a dozen line drawings, which showed both the surface and the underside of the button/fabric combination as well as many needle positions.

Accommodating the tendency of the reader to like and use pictures seems to be an important part of creating well-constructed procedural documents to enhance reader performance. For example, spatial information presented in pictures led to shortened

assembly times in a task involving small plastic and metal parts (Stone,1977a; Bieger & Glock, 1984, 1986).

Although graphics seem to be very powerful informative devices, when used alone they appear to be insufficient to encourage optimal task performance (see Hayes & Henk, 1983, 1984; Stone, 1977a, 1977b; Stone & Glock, 1981). Therefore, although it is tempting to use pictures exclusively, it seems that adding text is necessary for optimal performance.

Text. The text which accompanies graphics must be examined from several viewpoints. Some researchers have documented sentence formats which seem to help the reader. For example, sentences of the type "The square is inside the circle" increased subjects' success in a visualizing and drawing task more than sentences of the type "Inside the circle is a square" or "The circle has a square inside" (Seymour, 1974). Action-first sentences, such as "Draw a circle above a square" have been found to be read more quickly than condition-first sentences, such as "Above a square draw a circle." (Wright & Wilcox, 1978). Imperatives also seem to shorten response time. For instance, "Please make the circle blue" contributed to shorter response times than "Can you make the circle blue?" (Clark & Lucy, 1975).

Actual wording has been found to affect accuracy of assembly. For example, Schorr and Glock (1983) concluded that instructions containing explicit, or detailed, operational information (e.g., "Slide a short rod....") led to greater accuracy of assembly than instructions including only general operational information (e.g., "Move a short rod...."). Spatial information presented in text can lead to fewer errors in assembly tasks, too (Stone, 1977a; Bieger & Glock, 1984, 1986). The reader is apparently aided by text when it is explicit. A trade-off seems to exist between increased speed and reduced errors (see Bieger & Glock, 1986) with important educational implications for instructional design (see also Booher, 1973, cited in Reynolds & Booher, 1980). Deciding which is the more important - speed or accuracy - will determine the type of instructions created, those with many pictures for speed, or those with text for accuracy. The nature of the task, the type of equipment required, and the coordination and experience of the reader will also impact this decision (see Burnham, 1991).

One of the cognitive processes believed to aid successful completion of written instructions for procedural tasks is the formation of a conceptual model (Guthrie, Bennett, & Weber, 1990). The text of instructions can help the reader form this mental idea of how

to do the task by providing an outcome schema, a mental structure allowing the reader to know where s/he is headed (see Anderson & Pearson, 1984 for a discussion of schemata). Dixon (1982) distinguished between action and condition information, presenting readers with instructions to make adjustments among buttons or knobs on a control panel for an electronic device, a performance (e.g., "Turn the left knob when the alpha meter reads 20," and "When the alpha meter reads 20, turn the left knob"), and concluded that plans are organized around actions and that condition information is only remembered in relation to particular actions. When the outcome is a performance, presenting the outcome information first seemed to increase the effectiveness of processing the document. In other words, when the reader knew where s/he was headed, it was easier to get there.

The outcome of procedural instructions may be an object, as well. When organizational information (information about the outcome) was presented before component step information (information about the action), directions were processed more efficiently. For example, the sentence "You can make a wagon by drawing a long rectangle with two circles underneath" took less time to read than "By drawing a long rectangle with two circles underneath you can make a wagon" (Dixon, 1987c).

The written portion of instructions has yet another affect on the reader. Instructions generally consist of information that must be processed step by step. The manner in which those steps are presented may affect the ease of processing the instructions. For example, Smith and Goodman (1984) found differences in processing time and efficiency of processing when instructions for assembling a simple electric circuit were presented in three different formats--one linear (step by step format with no elaboration) and two hierarchical (divided into multiple levels of schema material). Subjects who received the hierarchical versions, which contained both explanatory material and steps (and which were, therefore, much longer), read the steps faster, recalled and executed them more accurately, and showed better transfer than subjects who received the linear version. In both of the hierarchical versions, Smith and Goodman provided a procedural schema for the relationships among ideas, actions, and component pieces (see also Dixon, 1987a and Graesser, 1978).

The hierarchical versions seem to help the reader transform the written instructions into actions, the major task when using written instructions for procedural tasks. The efficient mental encoding of the procedure, identifying "separate, executable steps" and

"entering them into memory" (Guthrie, Bennet, & Weber, 1990, p. 9, 5) assists in successful transformations.

Encoding the Procedure

By definition, procedures contain some representation of separate actions which the reader must change from verbal/graphic information to visual-spatial information upon which s/he can act. Following written directions has been found to impose a heavy cognitive load (Glover, Harvey, & Corkill, 1988; Glover, Timme, Deyloff, Rogers, & Dinell, 1987), so most people appear to iterate. That is, a step is encoded, executed, checked in various ways, and then the reader moves on to the next step, having consulted both text and graphics (Hayes & Henk, 1984). The limited size of short-term memory contributes to the iteration process. What actually occurs includes the likelihood of losing one's place in the instructions, due to the reading, doing, checking, and looking back and forth between equipment and instructions.

Tools found to be helpful to readers include listing (Carliner, 1987; Frase & Schwartz, 1979; Hartley, 1981; Schoff & Robinson, 1984), and the many formulas and guidelines used in military procedure-training-aids and technical manuals (Braby, Hamel, & Smode, 1982; Curran & Mecherikoff, 1979; Johnson, 1976; Kern et al., 1975; Siegel, Lambert, & Burkett, 1974; Terrell, Ewell, Scott, & Braby, 1983). Numbered steps or steps identified by consecutive letters of the alphabet are common choices which seem to help the reader keep track of where in the instructions s/he was when last s/he was reading (see Burnham, 1991).

Comparison of Three Instructional Texts. The three texts in Appendices A and B may be examined to determine how helpful each is from the viewpoint of well constructed text. The term "written" is not used here to indicate that instructions must be crafted, keeping in mind the preceding results from many researchers and the suggestions of Guthrie, Bennet, and Weber (1990) which seem to be fairly useful. Guthrie and his colleagues suggest that procedural documents must include exposition of the outcome, or introductory material, to enable the reader to form a conceptual model of the task--a mental idea of how to do it. Neither Text A nor Text B has adequate introductory exposition. Text A has two sentences of irrelevant material about sewing buttons so they "stay put" and no definition of the term "shank." Text B has four sentences somewhat more related to the task, but which use the term "shank" without a definition. Neither Text A nor

Text B show a finished shank labeled as such. Among subjects who used these two texts were four subjects who did not read the introductory material, but instead, began with the instructions. The quality of their product using Text A or Text B was worse than that of the product made without any instructions, which seems to indicate that reading even inadequate exposition might contribute to improved performance (Burnham, 1991).

In contrast, the experimental instructions (Appendix B) includes an expository paragraph, in which both the definition and purpose of a shank are given, and a drawing of a finished button/shank with the shank clearly labeled. The statistical analyses supported the conclusion that the experimental instructions were more helpful to students than either of the other two texts (Burnham, 1991); this might be a result, in part, of differences in the expository material.

Guthrie et al. also suggest that the use of a procedural schema can help the reader encode the steps. No evidence of any procedural schema can be found in either Text A or Text B--that is, neither has either numbered sequences or information presented as distinct steps. In both texts the instructions are presented in paragraph form, with no indentation, underlining, or other typographic tool used to identify separate steps. The lack of a procedural schema seemed to create problems for some subjects who used Texts A and B; a few revealed in their thinking-aloud that they had lost their place and were trying to relocate in the text. Transcripts also revealed that many subjects using Texts A and B reread previously used information, or information out of order (Burnham, 1991).

A procedural schema was used in the experimental instructions. The experimental instructions were divided into four major segments and individual steps in each segment were numbered and clearly separated from each other. Subjects who used the experimental instructions did not verbalize as much difficulty in maintaining their place in the text or in understanding and following the order of the steps as subjects who used either of the other two texts (Burnham, 1991).

The representation of the outcome, whether conveyed by pictures or in sentences, is an information source hypothesized by Guthrie et al. (1990) as essential to successful procedural document processing. The three texts under examination differ greatly in how the outcome is represented, both pictorially and verbally. Both Texts A and B have only two illustrations each-- apparently too few to convey to the reader the various needle, button, and toothpick positions and movements. In Text A there are letter labels on the

photographs, but one is hidden in the shadow of the toothpick, and in Text B neither drawing has a number or letter label to help the reader decide where to look. Text A has photographs, which reproduced poorly, even in the original, and Text B has line drawings. In all four illustrations the underside of the fabric is not shown and little perspective is given to help the student calculate hand positions relative the equipment.

In contrast to Texts A and B, the experimental instructions includes fifteen line drawings. The two sides of the fabric are differentiated from each other, the button location marking is visible, and many needle and button positions required by the task are illustrated. Some of the drawings also show the needle piercing the fabric and emerging on the underside, which neither Text A nor Text B includes. The quality of product made using these instructions seems to support Guthrie et al. in their call for adequate graphic representation of the outcome, in that the experimental instructions enabled students to make a better product (Burnham, 1991).

The sentences used in Texts A and B to represent the outcome also seem to be inadequate. In these two texts many vague terms are used, and few definitions are given. Instructions are equally vague (e. g., "Sew through holes of button sewing over pick" in Text A, and "Wind thread firmly around stitches to make shank" in Text B). Among the ten subjects who made a better product without instructions than with instructions, five used Text A, and two used Text B, and all seven of these stated that they were guessing what to do while following the instructions. The guessing was probably related to the vagueness of the instructions and the lack of definitions (Burnham, 1991).

Conversely, students who used the experimental text were able to find a definition of "shank" in the first paragraph. They also could read specifically stated sentences in which there was little chance to misinterpret the information (e.g., "Repeat Steps 5, 6, and 7 using the same two holes until you have 3 or 4 stitches around the toothpick.") Action information was given before condition information (e.g., Steps 1,2,3,4,8,10,13,16,17) (see Dixon, 1982), and organizational information was given before component step information (e. g., Steps 5,6,7,9,12,15) (see Dixon 1987a). The fact that students who used this text made better buttons than the other students (Burnham, 1991) seems to support Guthrie et al. in their demand for adequate verbal representation of the outcome.

In developing the experimental text, efforts were made to avoid the problems associated with inadequate exposition, the lack of procedural schema, and inadequate

representation of the outcome. Although the experimental instructions were lengthy, and required almost three times as long for processing as either Text A or Text B, it appeared that there were characteristics of the experimental text that were helpful to students. More adequate exposition (including a definition of "shank"), the picture of a finished shank labeled as such at the start of the instructions, the use of many line drawings and numbered steps all appear to have contributed to improved task performance.

The improved scores of students using the experimental text must be examined in light of the increased time to perform the task, however. If a student takes more time, it is likely that a better product will result. The question to be considered then, is whether it matters that students take much more time to perform the task, if they do it well. Considering that most students will probably improve with practice, perhaps doing the task slowly the first few times becomes less important. The importance of the time factor probably also varies from task to task. Of course, the setting for the task, the presence or absence of supervision, and many other factors influence the application of these findings, but it appears that there are some characteristics of written instructions for procedural tasks which can help the reader perform better.

Developing Written Instructions for Procedural Tasks or Supplementing Existing Instructions

Aside from incorporating the previously discussed characteristics of well-constructed instructions for procedural tasks, there may be other text features the author can add to improve reader performance. Guthrie, Bennett, and Weber (1990) speculate that increased amounts of self-testing (asking oneself "Do I understand what I've read and have I done it correctly?) and self correcting (repairing mistakes identified by self-testing) while performing written instructions for procedural tasks can help create a better performance.

When high school students used texts written with interruptions (places where they were to compare their product to a picture and rate how well their product matched the picture) they did indeed engage in more correcting activities (Burnham & Anderson, 1991). There were variations, however, in their ability to use the interruptions to best advantage. For example, 9th grade students performed best when not interrupted at all, while 10th, 11th, and 12th grade students did best when interrupted a total of 5 times in a 17 step procedure . When these students had the option of simply comparing their product to the picture instead of being required to rate the product on a five-point scale, they did

not engage in statistically significantly greater amounts of self-correcting activities (Burnham & Anderson, 1991). The conclusion was that such characteristics as grade level, gender, reading level, and coordination (all of which were measured in the study) impacted performance, but that certain text features did encourage some readers to perform more effectively, and that simply having the opportunity to examine the product was not enough to improve performance.

A corollary finding of the Burnham and Anderson (1991) study was that even though the students did engage in greater amounts of self-testing and self-correcting, the quality of the finished product did not increase significantly. Although the students did engage in more correcting activities, what they did did not help. Possible reasons for this somewhat surprising result include a lack of experience with the task (those who were more familiar with the task were also more familiar with effective corrections), poor coordination or manual dexterity, the fact that whatever corrections a reader made had to be invented on the spot, and the usual limitations of the experimental setting (see Burnham & Anderson, 1991).

Well - constructed instructions for procedural tasks might be improved by including possible corrections, i.e. statements to the effect "should thus and so occur, do thus and so to correct" or pictures indicating what the product should not look like. (The five-interruption experimental text (Burnham& Anderson, 1991) included such a picture.) Another strategy is to separate advice to the reader from actual instructions in the steps. The experimental instructions in Appendix B have a separate column on the far right of each page for "Pointers", pieces of advice which are intended to help eliminate problems before they occur. These statements seemed to help the readers avoid particular problems, and also streamlined the actual instructional text (see Burnham, 1991). For example, one frequent warning was to not pull the thread so tight that the toothpick would not slide back and forth. None of the readers had trouble removing the toothpick because of tight stitches (see Burnham & Anderson 1991).

Summary

Briefly stated, what we know about improving written instructions for procedural tasks includes the following.

1. Provide adequate introductory exposition about the outcome of the instructions. A short paragraph with a picture appears to be very useful. Define important terms.

2. Represent the procedure in a list of separate, executable actions. Do not be afraid to use a hierarchical format, one with explanatory material as well as steps. Presenting the reader with the relationships between actions and progress on the procedure seems to help (see Graesser, 1978).

3. Use numbers as markers for the steps.

4. Separate advice and warnings from actions in the steps.

5. Give the reader access to information about the outcome in the actual text . Give action information first in the sentences, as opposed to condition information (e.g., "Do X when Y happens" not "When Y happens, do X."); give organization information (information about the outcome) before step information ("To accomplish A do B" not "By doing B you can accomplish A.").

6. Give the reader access to information about the outcome in pictures. If possible, use them liberally. Line drawings seem most useful for spatial content information (see Dwyer, 1971,1972; Mandler & Parker, 1976; Mandler & Johnson, 1976; Readence & Moore, 1981).

7. Provide places for the reader to stop and examine the product, and compare it to a representation of how it should appear.

8. Consider including suggested corrections for common problems in the procedure.

9. Test instructions on novices at the task.

References

Applebee, A. N., Langer, J. A., & Mullis, I. V. S. (1987). *Learning to be literate in America: Reading, writing, and reasoning. The nation's report card.* Princeton, NJ: Educational Testing Service. (ERIC Document Reproduction Service No. ED 281 162).

Bieger, G. R., & Glock, M. D. (1984). The information content of picture-text instructions. *Journal of Experimental Education, 53*, 68-76.

Bieger, G. R., & Glock, M. D. (1986). Comprehending spatial and contextual information in picture-text instructions. *Journal of Experimental Education, 54*, 181-188.

Braby, R, Hamel, C. J., & Smode, A. F. (1982). *Handbook of format models for designers of technical training materials.* (ERIC Document Reproduction Service No. ED 226 135).

Burnham, C. (1991). *Testing a model of procedural document processing.* Ann Arbor, MI: University Microfilms International.

Burnham, C., & Anderson. T. H. (1991). *Learning to sew on a button by reading a procedural text (Tech Rep No. 543).* Urbana: University of Illinois, Center for the Study of Reading.

Carliner, S. (1987). Lists: The ultimate organizer for engineering writing. *IEEE Transactions on Professional Communication*, PC-30(*4*), 218-221.

Chang, K. L. (1983). *An investigation of the curricular and occupational reading demands of the plumbing trade.* Unpublished master's thesis, University of Calgary, Canada.

Clark, H. H., & Lucy, P. (1975). Understanding what is meant from what is said: A study of conversationally conveyed requests. *Journal of Verbal Learning and Verbal Behavior, 14*, 56-72.

Cranney, A. G., Rowley, M., & Stonehocker, L. (1984). *The reading skills of home economics: Problems and selected references.* (ERIC Document Reproduction Service No. ED 249 476).

Curran, T. E., & Mecherikoff, M. (1979). *Toward more comprehensible technical manual graphics. Final report.* (ERIC Document Reproduction Service No. ED 179 198).

Diehl, W. A., & Mikulecky, L. (1980). The nature of reading at work. *Journal of Reading, 24*, 221-227.

Diehl, V. A., Mills, C. B., Birkmire, E. P., & Mou, L. (1989, March). *Procedural texts: Predictions of judgments of importance from structural models.* Paper presented at the annual meeting of the American Educational Research Association, San Francisco, CA.

Dixon, P. (1982). Plans and written directions for complex tasks. *Journal of Verbal Learning and Verbal Behavior, 21*(1), 70-84.

Dixon, P. (1987a). The processing of organizational and component step information in written directions. *Journal of Memory and Language, 26*, 24-35.

Dixon, P. (1987b). The structure of mental plans for following directions. *Journal of Experimental Psychology, 13*(1), 18-26.

Dixon, P. (1987c). Actions and procedural directions. In R. S. Tomlin (Ed.), *Coherence and grounding in discourse* (pp. 69-89). Philadelphia: John Benjamins.

Dwyer, F. M. (1971). Assessing students' perceptions of the instructional value of visual illustrations used to complement programmed instruction. *Programmed Learning and Educational Technology*, 8, 73-80.

Dwyer, F. M. (1972). The effect of overt responses in improving visually programmed science instruction. *Journal of Research in Science Teaching, 9*, 47-55.

Fox, B. J., & Siedow, M. D. (1980). Written directions for content area classrooms--Do students understand the teachers? *Clearing House, 54*, 101-104.

Frase, L. T., & Schwartz, B. J. (1979). Typographical cues that facilitate comprehension. *Journal of Educational Psychology, 71*(2), 197-206.

Glover, J. A., Harvey, A. L., & Corkill, A. J. (1988). Remembering written instructions: Tab A goes into slot C, or does it? *British Journal of Educational Psychology, 58*, 191-200.

Glover, J. A., Timme, V., Deyloff, D., Rogers, M., & Dinell, D. (1987). Oral directions: Remembering what to do when. *Journal of Educational Research, 81*(1), 33-40.

Graesser, A. C. (1978). How to catch a fish: The memory and representation of common procedures. *Discourse Processes, 1*, 72-89.

Guthrie, J. T., Bennett, S., & Weber, S. (1990). *Processing procedural documents: A transformational model.* Unpublished manuscript. University of Maryland.

Guthrie, J. T., Schafer, W. D., & Hutchinson, S. (1989, March). *Relationships of document literacy and prose literacy to occupational and societal characteristics of young black and white adults.* Paper presented at the annual meeting of the American Educational Research Association, San Francisco, CA.

Guthrie, J. T., Schafer, W. D., & Wang, Y. (1990). *Document literacy and reading achievement among minority students at grades 3, 7, and 11.* Unpublished manuscript.

Haber, R. N. (1970). How we remember what we see. *Scientific American, 222*, 104-112.

Hartley, J. (1981). Eighty ways of improving instructional text. *IEEE Transactions on Professional Communication, PC-24*(1), 17-27.

Hayes, D. A., & Henk, W. A. (1983, April). *Facilitative effects of analogies and illustrations on understanding and remembering written directions.* Paper presented at the annual meeting of the American Educational Research Association, Montreal, Canada.

Hayes, D. A., & Henk, W. (1984, April). *Relative effects of analogies and pictures on understanding and remembering written directions.* Paper presented at the annual meeting of the American Educational Research Association, New Orleans, LA.

Hayes, D. A., & Henk, W. A. (1986). Understanding and remembering complex prose augmented by analogic and pictorial illustration. *Journal of Reading Behavior, 18*(1), 63-78.

Henk, W. A., & Helfeldt, J. P. (1987). How to develop independence in following written directions. *Journal of Reading, 30*(7), 602-607.

Johnson, R. C. (1976). Technical order usability. In T. G. Sticht & D. W. Zapf (Eds.), *Reading and readability research in the armed services* (pp. 236-248). Alexandria, VA: Human Resources Research Organization. (ERIC Document Reproduction Service No. ED 130 242).

Kern, R. P., Sticht, T. G., Welty, D., & Hauke, R. N. (1975). *Guidebook for the development of Army training literature. Combat training techniques.* Alexandria, VA: Human Resources Research Organization. (ERIC Document Reproduction Service No. ED 140 099).

Kintsch. W. (1985). Text processing: A psychological model. In T. E. van Dijk (Ed.), *Handbook of discourse analysis, Vol. 2* (pp. 231-243). London: Academic Press.

LeFevre, J., & Dixon, P. (1986). Do written instructions need examples? Cognition *and Instruction, 3*(1), 1-30.

Mandler, J. M., & Johnson, N. S. (1977). Remembrance of things parsed: Story structure and recall. *Cognitive Psychology, 9*, 111-151.

Mark, A. W., & Bracewell, R. J. (1989, March). *The role of descriptive information in the comprehension and performance of written instructions.* Paper presented at the annual meeting of the American Educational Research Association, San Francisco, CA.

Meyer, B. J. F. (1980). Use of top-level structure in text: Key for reading comprehension of ninth-grade students. *Reading Research Quarterly, 16*, 72-103.

Nickerson, R. S. (1965). Short-term memory for complex meaningful visual configurations: A demonstration of capacity. *Canadian Journal of Psychology, 19*(2), 155-160.

Readence, J. A., & Moore, D. W. (1981). A meta-analytic review of the effect of adjunct pictures on reading comprehension. *Psychology in the Schools, 18*(2), 218-224.

Reynolds, H. N., & Booher, H. R. (1980). The effects of pictorial and verbal instructional materials on the operational performance of deaf subjects. *Journal of Special Education, 14*(2), 175-187.

Schoff, G. H., & Robinson, P. A. (1984). *Writing and designing operator manuals.* Belmont, CA: Lifetime Learning Publications.

Schorr, F. L., & Glock, M. D. (1983). *Comprehending procedural instructions: The influence of comprehension monitoring strategies and instructional materials.* (Tech. Rep. No. 10). Ithaca, NY: State University of New York, College of Agriculture and Life Sciences. (ERIC Document Reproduction Service NO. 236 333).

Seymour, P. H. K. (1974). Generation of a pictorial code. *Memory and Cognition, 2*(2), 224-232.

Shepard, R. N. (1967). Recognition memory for words, sentences and pictures. *Journal of Verbal Learning and Verbal Behavior, 6*, 156-163.

Siegel, A. I., Lambert, J. V., & Burkett, J. R. (1974). *Techniques for making written material more readable / comprehensible.* Lowry, AFB, CO: Air Force Human Resources Laboratory. (ERIC Document Reproduction Service No. ED 097 629).

Simon, H. A., & Hayes, J. R. (1976). Understanding complex task instructions. In D. Klare (Ed.), *Cognition and instruction* (pp. 269-285). Hillsdale, NJ: Erlbaum Associates.

Smith, E. E., & Goodman, L. (1984). Understanding written instructions: The role of an explanatory schema. *Cognition and Instruction, 1*(4), 359-396.

Standing, L., Conezio, J., & Haber, R. N. (1970). Perception and memory for pictures: Single-trial learning of 2500 visual stimuli. *Psychonomic Science, 19*(2), 73-74.

Sticht, T. G. (1975). *Reading for working: A functional literacy anthology.* Alexandria, VA.: Human Resources Research Organization (HumRRO).

Sticht, T. G., Fox, L. C., Hauke, R. N., & Welty-Zapf, D. (1977, September). *The role of reading in the Navy* (NPRDC-TR-77-40). San Diego, CA: Navy Personnel Research and Development Center. (NTIS No. AD A044 228). (ERIC Document Reproduction Service No. 149 300).

Stone, D. E. (1977a). *Comprehension of information in picture-text amalgams in procedural texts.* Unpublished doctoral dissertation, Cornell University, Ithaca, NY.

Stone, D. E. (1977b). *Text of picture-text amalgams in procedural texts.* (ERIC Document Reproduction Service No. ED 236 665) (Excerpted from author's doctoral dissertation, Cornell University, Ithaca, NY).

Stone, D. E., & Glock, M. D. (1981). How do young adults read directions with and without pictures? *Journal of Educational Psychology, 73*(3), 419-426.

Terrell,W. R., Ewell, R. C., Scott, P., & Braby, R. (1983). *The design and production of a procedure training aid using the procedure learning format and the computer automated page layout (PLA) routine.* Technical note 12-83. Orlando, FL: Naval Training Analysis and Evaluation Group. (ERIC Document Reproduction Service No. ED 244 579).

Trabasso, T., Secco, T., & van den Broek, P. (1984). Causal cohesion and story coherence. In H. Mandl, N. L., Stein, & T. Trabasso (Eds.), *Learning and comprehension of text*. Hillsdale, NJ: Erlbaum Associates.

Wright, P., & Wilcox, P. (1978). Following instructions: An exploratory trisection of imperatives. In W. J. Levelt & G. B. Flores d'Arcais (Eds.), *Studies in the perception of language* (pp. 129-153). New York: Wiley and Sons.

Appendix A

Buttons

Buttons come in all shapes and sizes, but actually, there are only two basic types—sew-through and shank. Whichever type you use, you can sew them on so they stay put.

Hand Sewing

Use a double strand of thread;

Sew-through button: Take a small stitch through fabric at button location. Place toothpick or wooden match on top of button; sew through holes of button, sewing over pick (C). Remove

toothpick. Wrap thread tightly around the thread under button, creating a shank (D). Without a shank, stress from the second fabric layer might cause the button to pop off. Anchor thread with a few little stitches.

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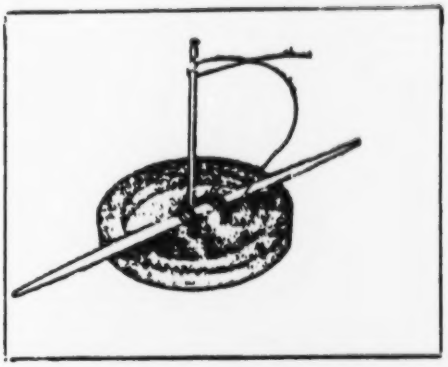
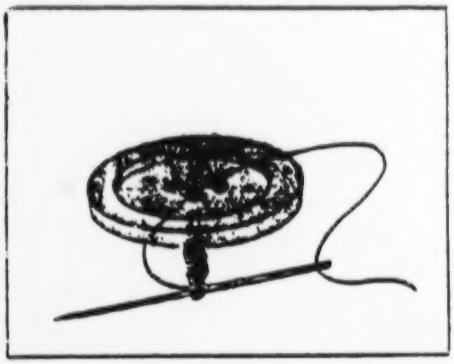
Attaching buttons

Sew-through buttons

A sew-through button has either two or four holes through which the button is sewed to the garment. When sewed flat, this button can be used as a closure only for very thin, lightweight fabrics, or as a decorative button. If a thread shank is added, the button can be used to close heavy or bulky fabrics as well. The shank permits the closure to fasten smoothly and will keep the fabric from pulling unevenly around the buttons.





To make a thread shank, secure thread at button mark, then bring needle up through one hole in button. Lay a pin, toothpick, or matchstick across top of button. Take needle down through second hole (and up through third, then down through fourth, if a 4-hole button); make about six stitches. Remove pin or stick, lift button away from fabric so stitches are taut, and wind thread firmly around stitches to make shank. Backstitch into shank to secure.

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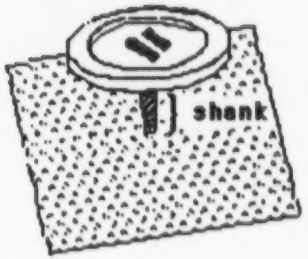
Appendix B

Sewing on a Button with a Thread Shank

Many garments are fastened with a button and buttonhole closure. A button needs a **shank** - a length of thread between the button and the fabric - so that the layer with the buttonhole will fit smoothly under the button. Then, when the garment is buttoned, the buttonhole will not spread and cause unsightly wrinkles.



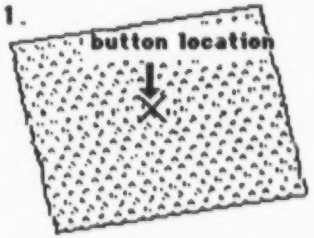
To sew on a flat button with a thread shank, follow Steps 1 - 17.

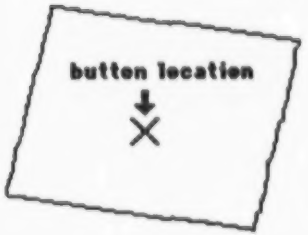
Pointers

Positioning Button

1. Mark the button location on both sides of the fabric using a sharp chalk pencil.

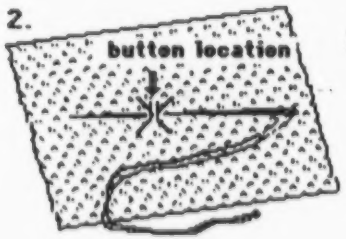
1.





2. Take a small stitch in the surface of the fabric at the button location marking using a needle threaded with a knotted double strand. Pull the thread through until the knot is on the surface of the fabric.

2.



2. Notice that the needle starts and finishes on the same side of the fabric.

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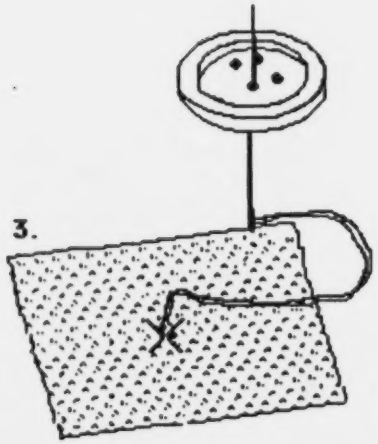
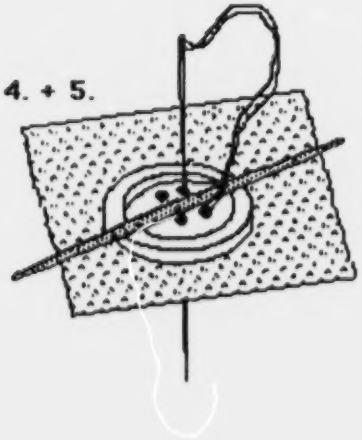
Positioning Button

3. Insert the tip of the needle into one of the holes in the button and pull the needle all the way through. Allow the button to slide down the thread until it rests on the surface of the fabric.



Forming Stitches

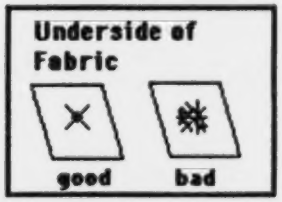
4. Place a round toothpick or matchstick on top of the button, so that it lies between the holes.



5. To make the first stitch, place the tip of the needle in the hole directly across the toothpick from the first hole and push it through the center of the X marking. Pull the needle and thread all the way through. The thread should now form a loop around the toothpick.

Pointers

Try to make your sample look like the "good" drawing.

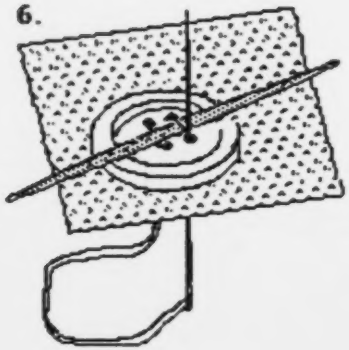


5. You will probably have to angle the needle to go through both the hole in the button and the center of the X.

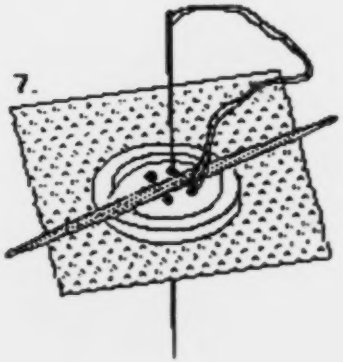
   Do not pull the thread so tight that the toothpick will not slide back and forth a little.

Forming Stitches

6. To begin the next stitch, push the needle through the center of the X marking on the underside of the fabric and through the first hole. Pull the needle all the way through, and pull the thread snug.



7. To finish the stitch, place the needle tip in the second hole again and push the needle through the button and fabric to the underside. Pull the thread to match the snugness of the first stitch.

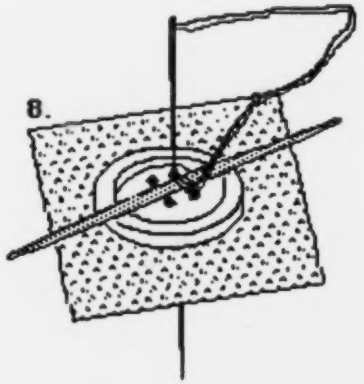


Pointers

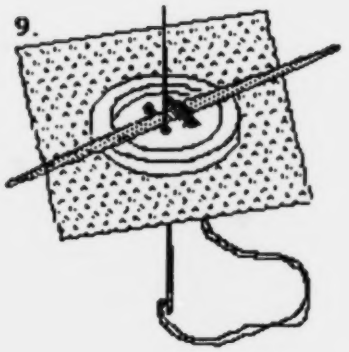
7. Do not pull the thread so tight that the toothpick will not slide back and forth a little.

Forming Stitches

8. Repeat Steps 5,6, and 7 using the same two holes until you have 3 or 4 stitches around the toothpick. End with the needle on the underside of the fabric.

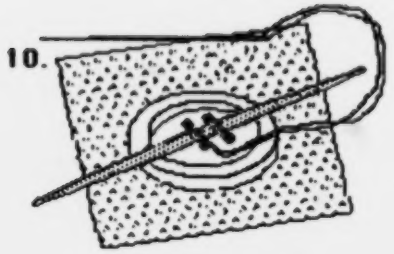


9. To finish attaching the button, use the remaining two holes. Push the needle tip through the fabric near the center of the X marking and through one of the two empty holes in the button. Pull the needle and thread all the way through.



Forming Stitches

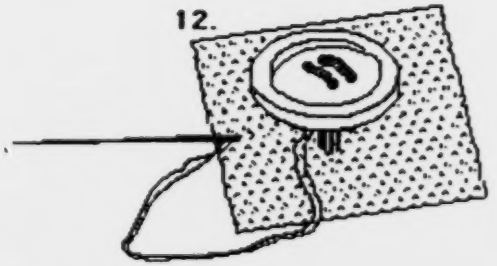
10. Repeat Steps 5,6, 7, and 8 using just the two remaining holes. **Stop** before pushing the needle down through the button and fabric on the last stitch.



Making the Shank

11. Remove the toothpick.

12. Complete the stitch by inserting the needle through the hole, but **not** through the fabric. Pull the needle and thread through the button.



Pointers

11. If you cannot remove the toothpick you have pulled the thread too tight. Gently wiggle the toothpick. If it still will not come out you will have to cut your thread and begin again.

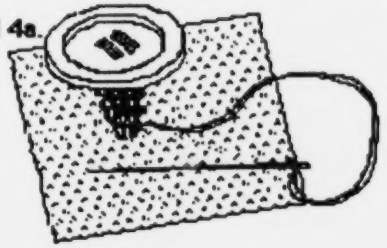
Making the Shank

13. Lay the fabric down on the table. If you are right-handed, hold the button between your left thumb and index finger. Hold the needle in your right hand. If you are left-handed, reverse the hand positions.

14. Holding the needle as directed in Step 13, and using a circular motion, wrap the supply thread snugly around the threads which join the button to the fabric. Start close to the button and wrap toward the surface of the fabric. Go around 3 or 4 times.

Pointers

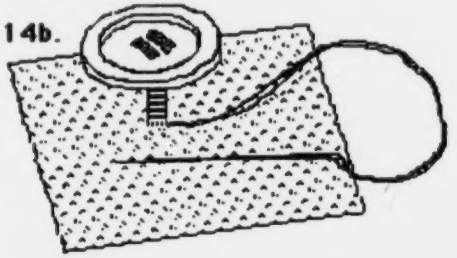
14a.



14. You will probably have to let go of the button with your left hand once on each wrap.

The shank should be uniform in width with no wrapped threads lying on top of each other.

14b.

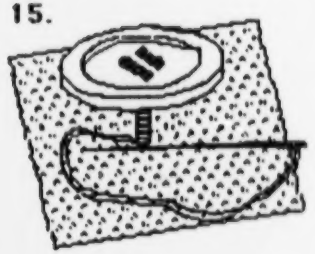


Examine the shank after 2 wraps. If the wrapped threads lie on top of each other, unwrap them. Rewrap so each wrap lies below the preceding one.

Securing Thread

15. To secure the thread, take 2 or 3 small stitches through the fabric at the base of the shank.

15.



16. Cut the supply thread near the needle. Separate the two strands and tie a square knot.

17. Cut the supply thread as close to the surface of the fabric as possible.